

Claims

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1. A DNA sequence encoding a cell cycle interacting protein or encoding an immunologically active and/or functional fragment of such a protein, selected from the group consisting of:

(a) DNA sequences

(aa) comprising a nucleotide sequence encoding at least the mature form of a protein (LDV115) comprising the amino acid sequence as given in SEQ ID NO: 2;

(ab) comprising the nucleotide sequence as given in SEQ ID NO: 1;

(ac) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (aa) or (ab) under stringent hybridization conditions;

(ad) comprising a nucleotide sequence encoding a protein having an amino acid sequence at least 60 % identical to the amino acid sequence encoded by the nucleotide sequence of (aa) or (ab);

(ae) comprising a nucleotide sequence encoding at least the domain binding to CDKs of the protein encoded by the nucleotide sequence of any one of (aa) to (ad);

(b) DNA sequences

(ba) comprising a nucleotide sequence encoding at least the mature form of a PHO80-like Protein (PLP) comprising the amino acid sequence as given in any one of SEQ ID NOs: 4, 34, 36, 38, 40 or 42;

(bb) comprising the nucleotide sequence as given in any one of SEQ ID NOs: 3, 33, 35, 37, 39 or 41;

(bc) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (ba) or (bb) under stringent hybridization conditions;

(bd) comprising a nucleotide sequence encoding a protein having an amino acid sequence at least 40 % identical to the amino acid sequence encoded by the nucleotide sequence of (ba) or (bb);

- (be) comprising a nucleotide sequence encoding at least the cyclin-like interacting domain of the protein encoded by the nucleotide sequence of any one of (ba) to (bd);
- (c) DNA sequences
- (ca) comprising a nucleotide sequence encoding at least the mature form of a protein (VB33) comprising the amino acid sequence as given in SEQ ID NO: 6;
- (cb) comprising the nucleotide sequence as given in SEQ ID NO: 5;
- (cc) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (ca) or (cb) under stringent hybridization conditions;
- (cd) comprising an nucleotide sequence encoding a protein having an amino acid sequence at least 60 % identical to the amino acid sequence encoded by the nucleotide sequence of (ca) or (cb);
- (ce) comprising a nucleotide sequence encoding at least the domain binding to CDKs of the protein encoded by the nucleotide sequence of any one of (ca) to (cd);
- (d) DNA sequences
- (da) comprising a nucleotide sequence encoding at least the mature form of a protein (VB89) comprising the amino acid sequence as given in SEQ ID NO: 8;
- (db) comprising the nucleotide sequence as given in SEQ ID NO: 7;
- (dc) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (da) or (db) under stringent hybridization conditions;
- (dd) comprising an nucleotide sequence encoding a protein having an amino acid sequence at least 60 % identical to the amino acid sequence encoded by the nucleotide sequence of (da) or (db);
- (de) comprising a nucleotide sequence encoding at least the domain binding to CDKs of the protein encoded by the nucleotide sequence of any one of (da) to (dd);
- (e) DNA sequences

- (ea) comprising a nucleotide sequence encoding at least the mature form of a protein (VBDAHP) comprising the amino acid sequence as given in SEQ ID NO: 10;
- (eb) comprising the nucleotide sequence as given in SEQ ID NO: 9;
- (ec) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (ea) or (eb) under stringent hybridization conditions;
- (ed) comprising an nucleotide sequence encoding a protein having an amino acid sequence at least 60 % identical to the amino acid sequence encoded by the nucleotide sequence of (ea) or (eb);
- (ee) comprising a nucleotide sequence encoding at least the domain binding to CDKs of the protein encoded by the nucleotide sequence of any one of (ea) to (ed);
- (f) DNA sequences
 - (fa) comprising a nucleotide sequence encoding at least the mature form of a protein (VBDBP) comprising the amino acid sequence as given in SEQ ID NO: 12;
 - (fb) comprising the nucleotide sequence as given in SEQ ID NO: 11;
 - (fc) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (fa) or (fb) under stringent hybridization conditions;
 - (fd) comprising an nucleotide sequence encoding a protein having an amino acid sequence at least 60 % identical to the amino acid sequence encoded by the nucleotide sequence of (fa) or (fb);
 - (fe) comprising a nucleotide sequence encoding at least the domain binding to CDKs of the protein encoded by the nucleotide sequence of any one of (fa) to (fd);
- (g) DNA sequences
 - (ga) comprising a nucleotide sequence encoding at least the mature form of a protein (VBHSF) comprising the amino acid sequence as given in SEQ ID NO: 14;
 - (gb) comprising the nucleotide sequence as given in SEQ ID NO: 13;

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- (gc) comprising a nucleotide sequence hybridizing with the complementary strand of a nucleotide sequence as defined in (ga) or (gb) under stringent hybridization conditions;
- (gd) comprising an nucleotide sequence encoding a protein having an amino acid sequence at least 60 % identical to the amino acid sequence encoded by the nucleotide sequence of (ga) or (gb);
- (ge) comprising a nucleotide sequence encoding at least the domain binding to CDKs of the protein encoded by the nucleotide sequence of any one of (ga) to (gd);
- (h) DNA sequences obtainable by screening an appropriate library under stringent conditions with a probe having at least 17 consecutive nucleotides of a nucleotide sequence of any one of SEQ ID NOs: 1, 3, 5, 7, 9, 11, 13, 15 to 33, 35, 37, 39, 41, 48, 49 or 53 to 57;
- (i) DNA sequences comprising a nucleotide sequence encoding a fragment of a protein encoded by a DNA sequence of any one of (a) to (h), wherein said fragment is capable of interacting with a cell cycle protein; and
- (j) DNA sequences, the nucleotide sequence of which is degenerate as a result of the genetic code to a nucleotide sequence of a DNA sequence as defined in any one of (a) to (i).

2. A method for identifying and obtaining cell cycle interacting proteins comprising a two-hybrid screening assay wherein CDC2a or CDC2b as a bait and a cDNA library of a plant cell suspension as prey are used.
3. The method of claim 2, wherein said CDC2a is CDC2aAt and CDC2b is CDC2bAt.
4. A DNA sequence encoding a cell cycle interacting protein obtainable by the method of claim 2 or 3.

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5. A nucleic acid molecule of at least 15 nucleotides in length hybridizing specifically with a DNA sequence of claim 1 or 4 or with a complementary strand thereof.
 6. A vector comprising a DNA sequence of claim 1 or 4.
 7. The vector of claim 6 which is an expression vector wherein the DNA sequence is operatively linked to one or more control sequences allowing the expression in prokaryotic and/or eukaryotic host cells.
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8. A host cell containing a vector of claim 6 or 7 or a DNA sequence of claim 1 or 4.
 9. The host cell of claim 8 which is a bacterial, insect, fungal, plant or animal cell.
- Sub A3 >
10. A method for the production of a cell cycle interacting protein or an immunologically active or functional fragment thereof comprising culturing a host cell of claim 8 or 9 under conditions allowing the expression of the protein and recovering the produced protein from the culture.
 11. A cell cycle interacting protein or an immunologically active or functional fragment thereof encodable by a DNA sequence of claim 1 or 4 or obtainable by the method of claim 2, 3 or 10.
 12. An antibody specifically recognizing the protein of claim 11 or a fragment or epitope thereof.
- Sub A4 >
13. A method for the production of transgenic plants, plant cells or plant tissue comprising the introduction of a DNA sequence of claim 1, 4 or 5 or a vector of claim 6 or 7 into the genome of said plant, plant cell or plant tissue.
 14. The method of claim 13 further comprising regenerating a plant from said plant tissue or plant cell.

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A5 15. A transgenic plant cell comprising a DNA sequence of claim 1 or 4 which is operably linked to regulatory elements allowing transcription and/or expression of the DNA sequence in plant cells or obtainable according to the method of claim 13 or 14.

16. The transgenic plant cell of claim 15 wherein said DNA sequence or said vector is stably integrated into the genome of the plant cell.

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A6 17. A transgenic plant or a plant tissue comprising plant cells of claim 15 or 16.

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A5 18. The transgenic plant of claim 17 in which plant cell division and/or growth is enhanced and/or wherein the plant is less sensitive to environmental stress compared to the corresponding wild type plant.

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A7 19. A transgenic plant cell which contains stably integrated into the genome a DNA sequence of claim 1, 4 or 5 or part thereof or obtainable according to the method of claim 13 or 14, wherein the transcription and/or expression of the DNA sequence or part thereof leads to reduction of the synthesis of a cell cycle interacting protein in the cells.

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A5 20. The plant cell of claim 19, wherein the reduction is achieved by an antisense, sense, ribozyme, co-suppression, dominant mutant effect and/or a knock out mutant in the gene.

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A8 21. A transgenic plant or plant tissue comprising plant cells of claim 19 or 20.

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A5 22. The transgenic plant of claim 21 which displays a deficiency in plant cell division and/or growth.

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A9 23. Harvestable parts or propagation material of plants of any one of claims 17, 18, 21 or 22 comprising plant cells of claim 15, 16, 19 or 20.

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of interacting with the protein under suitable conditions which permit interaction of the protein with said readout system;

- (b) identifying or verifying a sample and compound, respectively, which leads to suppression or activation of the readout system.

31. A method of producing a therapeutic agent comprising the steps of the method of claim 30 and synthesizing the activator or inhibitor obtained or identified in step (b) or an analog or derivative thereof in an amount sufficient to provide said agent in a therapeutically effective amount to a patient.
32. A method of producing a plant effective agent comprising the steps of the method of claim 30 and synthesizing the activator or inhibitor obtained or identified in step (b) or an analog or derivative thereof in an effective amount sufficient to provide said agent in an effective amount suitable for the application in agriculture or plant cell and tissue culture.
33. A method of producing a therapeutic or plant effective composition comprising the steps of the method of claim 30 and combining the compound obtained or identified in step (b) or an analog or derivative thereof with a pharmaceutically acceptable carrier or with a plant cell and tissue culture acceptable carrier.
34. An ~~activator or inhibitor~~ of a cell division obtained by the method of any one of claims 30 to 32.
35. A composition comprising a ~~DNA~~ sequence of claim 1, 4 or 5, a vector of claim 6 or 7, a protein of claim 11, an antibody of claim 12, or the activator or inhibitor of claim 34.
36. The composition of claim 35 for use as a medicament, a diagnostic means, a kit or plant effective agent.

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37. Use of a DNA sequence of claim 1, 4 or 5, the vector of claim 6 or 7, the protein of claim 11, the antibody of claim 12 or the activator or inhibitor of claim 34 for modulating the cell cycle in an animal or plant, plant cell division and/or growth, for influencing the activity of cell cycle proteins in a plant or animal cell, as positive or negative regulator of cell proliferation, for modifying the growth inhibition caused by environmental stress conditions, for use in a screening method for the identification of inhibitors or activators of cell cycle proteins, as growth regulator, herbicide or for inducing nematode resistance in plants.
38. Use of a DNA sequence of claim 1, 4 or 5 or the regulatory sequence of claim 24 as a marker gene in plant or animal cell and tissue culture or as a marker in marker-assisted plant breeding.
39. Use of the two-hybrid system as defined in claim 2 or 3 for the identification of cell cycle interacting proteins or activators or inhibitors of such proteins.
40. Use of a regulatory sequence of claim 24 or a recombinant DNA molecule of claim 25 or 26, for the expression of a heterologous DNA sequence during a stage of the cell cycle.
41. A method for improving the tolerance of plants towards suboptimal nutrient conditions, preferably the level of phosphate, by modulating PLP expression and/or activity.
42. A method for improving the growth of plants in normal conditions or suboptimal nutrient conditions, in particular levels of phosphate, by modulating PLP expression and/or activity.
43. A method for providing enhanced rate or frequency of seed germination comprising modulating PLP expression and/or activity.

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P20 } 44. Use of a PLP as a positive or negative selectable marker during transformation of plant cell, plant tissue or plant. procedures.
45. The use of claim 44, wherein selective agent is an antibiotic, preferably hygromycin.

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